ART. XV.—*On Chlorine as a Solvent of Gold.* By the Rev. JOHN J. BLEASDALE, D.D.

[Read 21th May, 1862.]

Chlorine is here considered as a substitute for mercury, both on account of its comparative cheapness, the smaller quantity of water needed, and its capability of dissolving out a quantity of gold to which the mercury, for reasons to be given, cannot attain.

These disadvantages of the mercury process, are: 1st. Repulsion between the fine particles of quartz and mercury; and 2nd, the necessity of keeping the quartz, mercury, and water in a state of constant agitation, in order that the mercury may have a chance of coming in contact with the gold.

Now, though the contrivances already devised for effecting these purposes are very good, and seem to have reached the limits of human ingenuity, as anyone may see who will pay a visit to the Mining Museum at the University, yet they are very far from being able to remove the whole of the gold. It has been thought that forty per cent. of the finer gold is lost in the mercury process. I cannot state from personal observation, but even supposing only twenty per cent. to be lost, the loss is enormous. I speak of twenty per cent. that was in existence in the quartz when put into the mill to be crushed. The currents of water and the various beautiful contrivances for bringing the mercury and gold into contact, keep a large quantity of the finely crushed gold afloat, and consequently float it away. There is, moreover, a deal of gold in a state of extremely fine division in the matrix, almost invisible to the unaided eye, but evident when put under a microscope of but low power. Experiments performed upon samples of rock containing gold in this state, from Steiglitz, Ballaarat, and the Ovens, were several times repeated by my friend the late Count John Dembinski and myself. Our experiments were necessarily on a small scale, but yet sufficient to yield pretty reliable results of a comparative kind. For example, equal weights of the same specimens were roasted, crushed, and amalgamated carefully, and the corresponding halves roasted, crushed, and treated with chlorine, in the manner which I shall describe by-and-by. The mean of four experiments showed an increase by the chlorine process of nearly thirty-eight per cent. over the mercury.

Experiments which I have performed since the death of my friend with sea-sand and gold, in a state of as minute division as I could reduce them to, also favoured this view in a remarkable manner. Five grains of gold dust, or powder, obtained from precipitating it from the per-chloride, were divided into two equal parts, and each mixed with an equal weight of gold in a minute state of division already, each of these was then mixed with 5,000 grains of sea-sand, and the whole pounded together till it was in a fine powder. They were then each separately mixed with 5,000 grains of coarser sand, quartz-sand, and one submitted to amalgamation with mercury, and the other to the action of chlorine gas in a wooden vessel. The chlorine was forced into the sand, and then washed through with cold water. I obtained from five grains of gold in 10,000 grains sand, by the mercury process, 3.210 grains ; by the chlorine process, five grains in 10,000 sand, obtained 4.62 grains.

There appeared, after distilling over the mercury, that a very minute portion of gold adhered to the side of the vessel, (a Bohemian glass retort), a thin film, not more than a minute fraction of a grain.

I quote this as one of several experiments made sometimes with roasted quartz-rock, at others with sea-sand, and at others with both mixed, but always with a definite quantity of gold in a state of minute division.

I have not yet performed a sufficient number of experiments to satisfy my own mind as to the interference with thec hlorine, and its probable loss from metals or their oxides, as found associated with gold in the matrix. But from such as were made by Count Dembinski, by both of us, and latterly by myself, I anticipate little or none. When the quartz has been properly calcined previous to powdering, the chlorine will have no more action on the metallic oxides than upon the quartz itself. The titanic and magnetic iron, and the particles of iron introduced during the process of stamping, may be eliminated by a simple and inexpensive process, as follows :—

The ore at Richenstein, is an arsenical pyrites, containing about 200 grains of gold in the ton. The ore is roasted in a reverberatory furnace, surmounted by a large condensing chamber, in which arseneous acid is condensed as fast as it is volatilized. There then remains on the floor of the furnace oxide of iron mixed with a certain quantity of arsenic, together with the whole of the gold. This is placed

in a vessel so arranged that a current of chlorine can be passed through it, by which the gold and iron are taken up and afterwards separated from the residuum by the aid of a certain quantity of water, and the gold is afterwards precipitated from this solution by sulphuretted hydrogen. To prevent the admixture of iron at this stage, a small dose of hydrochloric acid is added to the solution before the sulphuretted hydrogen is introduced. The auriferous compound having been separated from the liquor, is washed and heated in an open porcelain crucible, to drive off the sulphur, after which the gold is reduced to the metallic state by heat in the usual manner.

This simple and ingenious method, which has made it worth while to reopen the Richenstein mine, is equally applicable to the vast quantity of refuse accumulated near many other old works. In awarding the Council medal, the jury have desired in this case to associate the name of Professor Plattner, the inventor of the method with that of M. Gualter, who has brought it into operation on a large scale.

Taking the above figures at their value as an experiment, I think they are unusually favourable to the mercury process, because the mixture was not subjected to so severe an agitation as is usual on the gold-fields, and consequently less would be floated away.

I can refer to one instance, mentioned by my friend, Dr. Otway, the owner of a Chilian mill at Steiglitz, of even mercury having been carried away by the stream in a state of very minute division, and having been found at a distance from the mill, deposited, and after repeated additions agglomerated into visible globules. I dare say persons constantly using those mills, if they observe the course of the water after passing through the amalgamating machinery, will be able to confirm this observation. I think no one doubts that there is a very considerable loss of fine gold in any of the present processes.

The cost of Chilian mills, the rapid wear and tear of machinery, and the expense of motive power, are very great. The quantity of water required is also very great. I regret that I have not been able to obtain full details of all these matters from reliable sources. The loss of mercury is variously estimated, but is always considerable. I think these are some of the well-known and generally admitted objections to the obtaining of gold by amalgamation.

The chlorine process, upon the success of which my late friend built all his hopes, is, so far as I can remember it, and so far as I have carried it out privately with him, and since his lamented death, the following :

Large wooden, or what is better, brick funnels, are filled, each with any quantity, say from ten tons to fifty tons of finely pulverized quartz, previously roasted and deprived of its coarsest gold, by sieving or sluicing. The chlorine gas, generated in a small cast-iron retort, of the capacity of two or three cubic feet (greater if it be found more advantageous), is forced into the funnels, and ascends through the quartz from the bottom upwards.

The action of the gas on the gold is very powerful. The energy of the reaction is in a degree not unlike combustion.

The gold is transformed into the per-chloride, which is very soluble in water.

This per-chloride of gold is washed out by water, fil tering slowly through the quartz from the top of the funnel, and falling into a receiver. From this solution all the gold is precipitated by means of a small quantity of sulphate of the protoxide of iron, the common green vitriol of the shops. The gold falls in the form of a brown powder, which on being fused in a crucible yields pure gold, twenty-four carats fine. Such is the process.

It may be in the recollection of some who are now present, I feel sure it is not forgotten by our respected secretary, who on one occasion assisted in this room to explain to a meeting, Count Dembinski's process, that he proposed to generate chlorine in the following manner: Finely pulverized quartz tailings are mixed with a common salt, and heated in a closed vessel to fusion, in the presence of super-heated steam. The reactions which take place yield silicate of soda and muriatic acid, which is collected in the usual manner. This is then worked up with per-oxide of manganese, and the chlorine set free.

During the latter weeks of his life, I suggested to him a simpler and cheaper process, one which would dispense with the use of any acid, save that of silicic, the quartz, and this was at once adopted.

This suggestion was to form a mixture of crude common salt (chloride of sodium), per-oxide of manganese, and silica, in proportion such as to form a double silicate, viz., a silicate of soda, and a silicate of the protoxide of manganese.

A mixture of one hundred parts of common salt, seventy-

five parts of peroxide of manganese, and ninety-five parts of silicic acid, will yield somewhat more than fifty parts of chlorine. Now those fifty parts of chlorine are capable of dissolving about ninety parts of gold.

In the western district of Victoria, and chiefly in the plains between Colac and Mount Mercer, and at a distance of between thirty and forty miles from Ballarat, and near the road from Geelong to Mount Ararat diggings, are several very large salt-pans, which in an ordinarily warm summer become quite dry, and in even a damp one become sufficiently evaporated to yield with little or no trouble thousands of tons of salt, which, however, is not much liked for ordinary purposes, because of a somewhat bitter taste, derived from the presence of a small quantity of chloride of magnesium. This, however, would not matter in the production of chlorine. I believe these salt-pans may be found in other districts also, where they might be easily turned to account.

The value of peroxide of manganese has of late years risen very high—its present price in England being near two pence per pound. It has been stated, however, on good authority, that this substance is very abundant in New Zealand, and should there be a demand for it in this country, it could be obtained there in any quantity, and at a very low price—say £5 or £6 a ton.

When I last met Dr. Otway, of Steiglitz, that enterprizing and intelligent gentleman assured me that per-oxide of manganese is found in considerable quantity at Steiglitz. It occurs in veins several inches thick, running parallel to, and frequently in immediate contact with auriferous quartz. Count Dembinski examined spots there known as Yankee Reef and Boxing Reef, and assured me that the auriferous quartz-vein was literally imbedded in a vein of per-oxide of manganese. He brought about a pound weight of the stuff, which we analyzed together.

Now putting all things at the worst, and supposing that it cost us here £30 per ton, and supposing also the price of salt to be £8 per ton, and one ton of coal, or fuel equal to it, to be £12, even then the production of those fifty pounds weight of chlorine gas, which are capable of dissolving about ninety weight of gold would cost at the very outside fifty shillings, including fuel and wear and tear of machinery. Probably the cost price would not be so great.

Now, for safety sake, I propose to use the chlorine in quan-

tities ten times as great as strictly required for dissolving all the gold. I suppose that a sample of the pulverized quartz has been previously tested, a thing which will be always done.

Assuming that rich quartz, after being deprived of its coarse gold by sieving or sluicing, contains on an average one and a-half or two ounces of gold to the ton in a state of almost atomic division, the cost of chlorine, applied in quantity forty fold greater than absolutely needed for its solution, will be about two for every ton of quartz.

The accounts of the loss of mercury in that process are very variously stated at, from four ounces to one pound per ton of quartz. Suppose a pound were lost, it would be in value about two shillings. Now that would be about the cost of the requisite amount of chlorine for such treatment as that just described.

It must never be forgotten, that scarcely one-tenth part of the water used in the Chilian mill is required in this process —making it available all the year round in dry places.

It has sometimes been urged against chlorine, that it is a deleterious agent, but when we remember the extensive use made of it in Great Britain, for the purposes of bleaching, such an objection ceases to be heeded.

ART. XVI.—*Abstract of a Paper on the Yield and Uses of Volatile Oils, from Native and Imported Plants, in the Colony of Victoria.* By J. BOSISTO, Esq.

Having paid considerable attention to the medicinal plants of Victoria and their products, and of late more particularly to those producing Volatile Oils, I am induced to lay before this Society my notes and observations upon some of the latter, and also to direct attention to the probable advantages of cultivating European plants which produce Volatile Oils.

The term "oils" applied to products of this nature often conveys a wrong impression, few persons calling to mind the distinctive characteristic expressed by the term "essential" or "volatile." A true Volatile Oil leaves behind no trace of grease when dropped on the finest fabric, nor does it injure the most delicate colour. Such are, with one exception, the Essential Oils in question.